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Acacia pendula (Fabaceae: Mimosoideae) in the Hunter Valley of New South Wales: Cunningham's collection from April 1825 and its implications

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Abstract

Previous debate on the status of *Acacia pendula* A.Cunn. (Fabaceae: Mimosoideae) in the natural flora of the Hunter region of New South Wales remains unresolved. However, the discovery of a journal entry and a specimen of *Acacia pendula* collected from 'Hunter's River' by Allan Cunningham in April 1825 potentially provide evidence for its long-term presence there. Close examination of a scan of this specimen reveals a poor match to the lectotype for this species, and its infertile nature means that it cannot be positively identified using taxonomic keys. Rediscovery of a small group of *Acacia* '*pendula*' plants near to where Cunningham travelled in 1825 confirms the sterile and root-suckering habit of the species which is consistent with those growing elsewhere in the region. Despite this find, Cunningham's journal entry and collection provide no confirmation that *Acacia pendula* naturally occurred extensively in the region (although it may have been very rare) but could suggest either that he had located one of the first introduced stands of the species in the region (through indigenous people or European settlers), or that these sterile root-suckering plants represent a currently un-named taxon or un-recognised hybrid. Final resolution of Hunter Valley populations of *Acacia pendula* s. lat. may only be attained through genetic studies.

Introduction

Acacia pendula A.Cunn. (Fabaceae: Mimosoideae) in the Hunter Valley of New South Wales is legally protected as an endangered population and forms an integral part of the critically endangered Hunter Valley Weeping Myall Woodland. Previous papers have debated the place of *Acacia pendula* as a natural component of the Hunter Valley vegetation (Bell & Driscoll 2014, 2016; Tozer & Chalmers 2015, 2016), however the entity remains legally protected. Uncertainty in its position within the naturally occurring Hunter flora stems from the paucity of observations contained in the journals of early explorers (relative to those documented for outside of the Hunter), the inconsistent database record of observations and collections over nearly 200 years of European settlement (heavily skewed to recent decades following legal protection of the species in the region), and the significantly different habitat (geology, soil, rainfall, elevation) between Hunter Valley plants

and those in more westerly districts. Hunter Valley populations are also heavily clonal and observational evidence indicates they never successfully reproduce sexually (Bell et al. 2007, Bell 2018).

The diaries of explorer-botanist Allan Cunningham are difficult to decipher (Figure 1), and the wealth of botanical (and other) information within them has been at risk of disappearing over time. Fortunately, long-term research presented in Orchard (2013, 2014) and Orchard and Orchard (2013–2018b) has been progressively transcribing and releasing a vast amount of this information for researchers. At the time, Bell and Driscoll (2014) argued that nowhere in Cunningham's diaries did he make mention of *Acacia pendula* in the Hunter Valley, and certainly not in the abundance it is perceived to have been present by some modern-day workers. The one exception noted by us at that time was a collection of *Acacia pendula* made by Cunningham at 'Hunter's River', but which we considered possibly an erroneous location and/or sufficiently morphologically distinct from that species to warrant questioning. A recent unpublished review of Cunningham's diary for his time spent around Mount Dangar in the upper Hunter Valley in April 1825, freshly transcribed by Tony Orchard, has uncovered a single previously overlooked mention of *Acacia pendula* (also recounted in Whitehead 2017). It is now appropriate that this observation, together with the 1825 collection made from 'Hunter's River' potentially linked to it, be re-examined more closely. It is noteworthy that this 1825 observation occurred eight years after Cunningham first collected the species from the Lachlan River, that specimen later designated as lectotype by Pedley (1978).

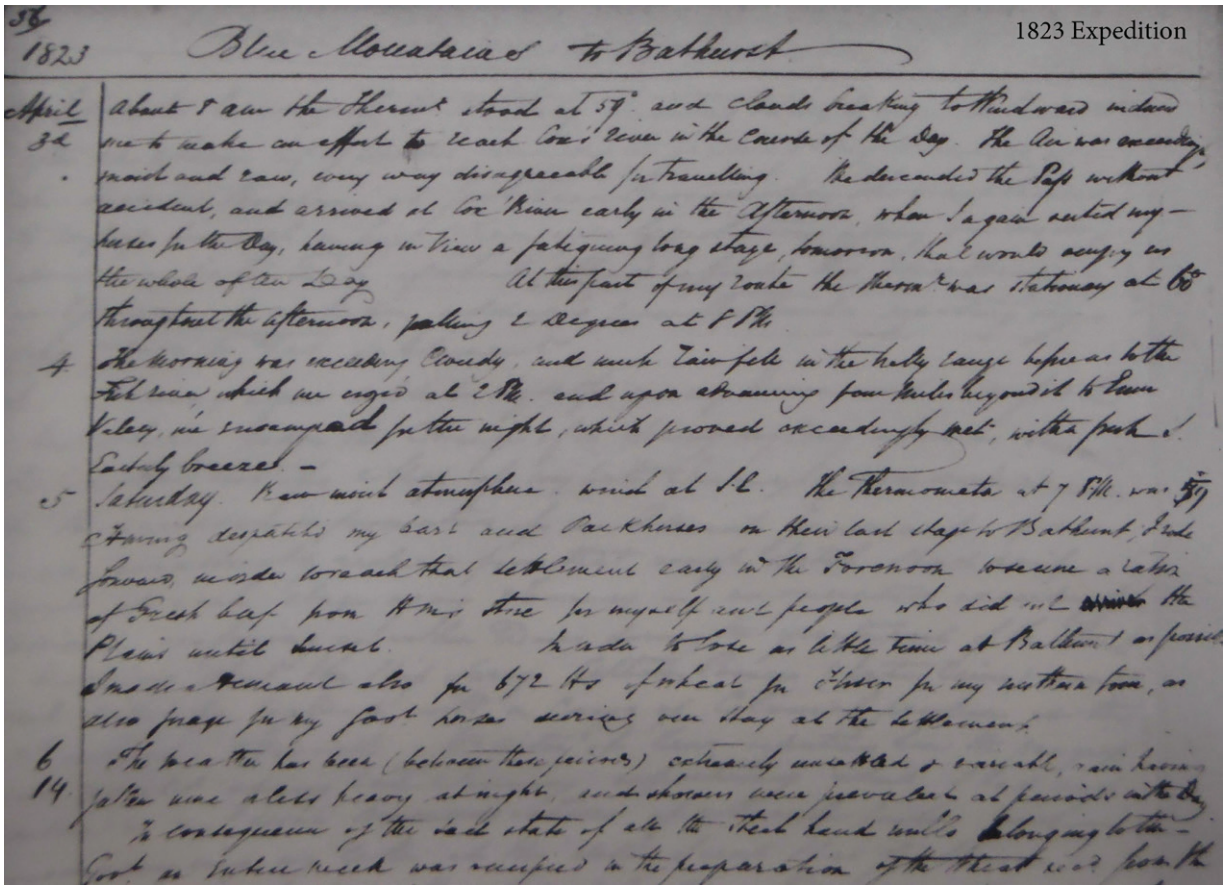

Fig. 1. An extract of Cunningham's diary from his 1823 expedition across the Blue Mountains to Bathurst.

Cunningham's April 1825 Collection

A collection of *Acacia pendula* is held within the Kew Herbarium (London), attributed to Cunningham collecting it from 'Hunter's River' in April 1825. Bell and Driscoll (2014) briefly discussed this collection, noting observable differences between it and more typical *Acacia pendula* collected elsewhere. Further, in the apparent absence of diarised notes from Cunningham concerning this species in the Hunter Valley, we suggested some uncertainty in the origin of that specimen. A comparison of the April 1825 collection of Cunningham against the lectotype for *Acacia pendula* (conveniently mounted on the same sheet at Kew) shows observable

morphological differences between the two (Figure 2, discussed below). The Hunter specimen is that shown on the left of this image (labelled as K000806169), collected from 'Hunter's River' in April 1825. The newly transcribed text from his diary entry for Sunday 24 April 1825 sees Cunningham write "*My Course for about 3 Miles was abt NNW, the land in patches exceedingly rich timbered, however with ordinary Trees of Iron bark, Blue Gum and Oak, a reedy Creek with rapid stream running easty towards the River, the flats of which being clothed with Appletree. Some soft boggy ground was covd with [?thin] grass a kind of Plantago (varia), beautiful undulated sheep-pasture [existing? axillary?] between the Hills. On the boggy flats* Acacia pendula*, assuming the arboresct growth reminded me of the Lachlan Marshes and in the grassy forest I was happy in remarking* Acacia spectabilis *likewise of that journey*" (T. Orchard pers comm). Careful assessment of his geographical position on this and the preceding days, together with mapping shown in Whitehead (2017), suggests that this observation was made near the locality of Gungal, approximately 10 km north-west of Sandy Hollow. This appears to be the only mention of *Acacia pendula* on this expedition within the Hunter Valley (T. Orchard pers comm), and it can be safely assumed that this diary entry represents the 'Hunter's River' collection.

Further examination of herbarium material shows that the lectotype for *Acacia pendula* (K000806170) was collected from the Lachlan River in 1817. This specimen has with it separately mounted pods and at least one seed, presumably from the same plant, but no flowers are present. The lectotype actually comprises four separate broken pieces that have been arranged according to growth habit during mounting. A fifth piece with pod attached has been mounted on the top left corner of this sheet, and examination of the colouration and morphology of phyllodes associated with it suggests it most likely belongs to the 1817 collection, perhaps dislodged from the lower middle section where a visible 'stub' is present. The label on this sheet was prepared by Cunningham's legatee Robert Heward and was part of the donation of Cunningham material that Heward made to Kew (T. Orchard pers comm). This label mentions three separate collections, the two noted above from Hunter's River (*Cunningham 113*, 1825) and the Lachlan River (*Cunningham 434*, 1817), and a third from Mitchells Expedition in 1835 from the "Nammoy [sic] River". The Mitchell expedition collection has been mounted separately on sheet K000806167, but lacks a precise location. Viewing of a scan of this material (Figure 3) is of interest as it shows it to be of similar colour and morphology as the 1817 collection from the Lachlan River, particularly with regard to the mucro present on the phyllode apices. Morphologically, the Hunter's River collection from 1825 bears little resemblance to either the 1817 or 1835 collections. There is a clear colour difference, the phyllodes are smaller and more closely packed along the branchlet, and apical mucros, a feature of *Acacia pendula*, are absent or poorly developed. Phyllode venation and indumentum characteristics, useful for identification purposes in this group, are not discernible on the scanned sheet. This collection is also infertile, and without viewing of pods and the alignment of seeds its identity cannot be ascertained with certainty.

To quantify some of these observations, the herbarium sheet images for the Hunter's River collection (*Cunningham 113*, 1825) and that designated as lectotype from the Lachlan River (*Cunningham 434*, 1817) were scaled to the provided scale bar and twenty measurements taken of phyllode length and width for each specimen. Mean lengths (mm) at Hunter's River were 43.6 ± 2.79 SE and at Lachlan River 55.15 ± 2.56 SE, while mean widths (mm) were 3.4 ± 0.112 SE at Hunter's River and 4.4 ± 0.222 SE at Lachlan River. A two-sample t-test showed both length ($t(38) = -3.05$, $p = 0.004$) and width ($t(38) = -4.01$, $p < 0.001$) to be significantly different between the two specimens. Phyllode density per centimetre of stem was also substantially different between the two, with two phyllodes/cm for Hunter's River and one phyllode/cm for Lachlan River.

Given that the 1817 collection has been designated as the lectotype for this species (Pedley 1978), and based on observed morphological differences and our extensive experience examining specimens in the field (both in the Hunter Valley and elsewhere), it remains unclear to us if the Hunter's River specimen is in fact *Acacia pendula*. Cunningham may have attributed his collection from the Hunter to *Acacia pendula* on an assumption, as is often done today, based solely on phyllodes without access to fertile material. Identification keys (e.g. PlantNET, https://plantnet.rbgsyd.nsw.gov.au/floraonline.htm; *Flora of Australia*, Orchard & Wilson 2001) all require an inspection of pods and seed alignment to separate this species from other similar arid-zone acacias, and without this material a conclusive identification often cannot be made. The habitat Cunningham described for the area where his *Acacia pendula* collection was made supported ironbark [=*Eucalyptus crebra*], blue gum [=*Eucalyptus blakelyi*], oak [=*Casuarina cunninghamiana*] and Appletree [=*Angophora floribunda*], with *Acacia pendula* on the 'boggy flats'. Such associated species are not typical of the species elsewhere in its range (Bell & Driscoll 2014), and indeed these species dominate remnant habitat associated with drainage lines across the bulk of the upper Hunter Valley today (pers. obs.). The absence of other collections or observations between 1825 and 1951 (the first contemporary record of the species: Bell & Driscoll 2014) in these areas by Cunningham and other observers suggests that the 'Hunter's River' collection represents an anomaly.

Fig. 2. Lectotype of *Acacia pendula* (K008086170; 1817), on the right, and the Hunter's River collection (K00806169; 1825) on the left, both collected by Cunningham. © Image copyright of the Board of Trustees of the Royal Botanic Gardens, Kew.

Fig. 3. *Acacia pendula* (K000806167) collected by Cunningham from the Namoi River on the Mitchell Expedition in 1835. © Image copyright of the Board of Trustees of the Royal Botanic Gardens, Kew.

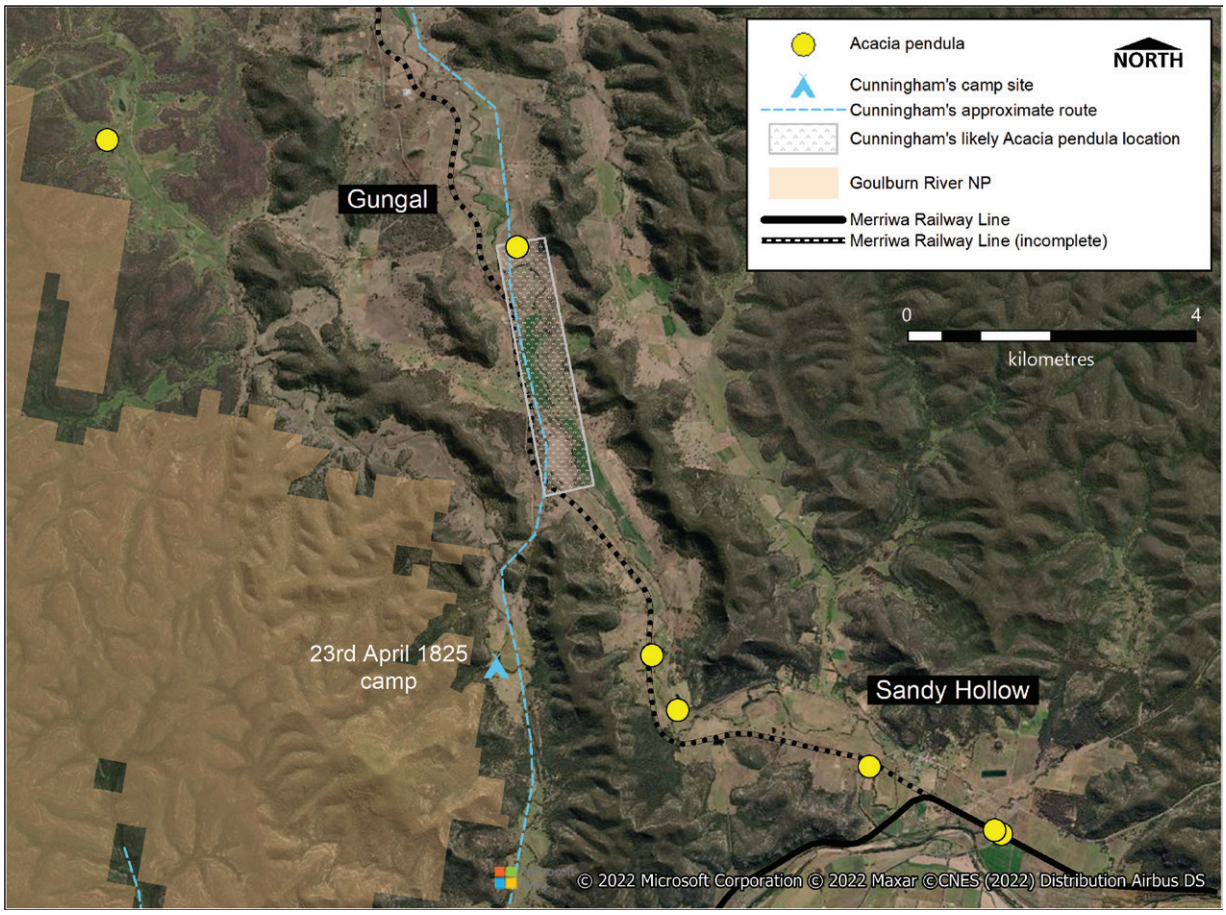

Fig. 4. Locations of relocated stands of purported *Acacia pendula* relative to Cunningham's April 1825 exploration route overlain on Google Maps imagery.

Fig. 5. Stand of *Acacia pendula* in cleared grazing land along Halls Creek, between Gungal and Sandy Hollow, now fenced to exclude grazing by cattle.

Fig. 6. Freshly collected specimen of purported *Acacia pendula* made from Worondi Rivulet at Gungal, approximately 7 km from Cunningham's collection area of April 1825. Scale bar = 4 cm.

Using the reconstructed diary notes of Cunningham and the work of Whitehead (2017), we relocated several small stands of purported *Acacia pendula* along Halls Creek between Gungal and Sandy Hollow, on or close to the route walked by him in 1825 (Figure 4). The habit and phyllodes of these trees is upright and erect (Figure 5) and phyllode morphology (Figure 6) is a good match for the material shown at left on K000806169, collected by Cunningham in April 1825 (see Figure 2). As with other occurrences in the Hunter Valley, dense stands have developed through root suckering following fencing to exclude grazing by cattle as a response to listing as a threatened population.

Implication of Cunningham's Collection

As detailed in Bell and Driscoll (2014), only horticultural specimens of *Acacia pendula* (likely originating from the Liverpool Plains) planted in the Hunter Valley flower and fruit freely, allowing confirmation of identity through examination of seed alignment within pods (i.e. transverse aligned seeds in winged pods). Other specimens (morphotypes B & C in Bell & Driscoll 2014) may flower occasionally but do not successfully set seed (Bell et al. 2007, Bell 2018), and as a result their identity as *Acacia pendula* have never been unequivocally confirmed. These plants are vigorously clonal, possibly in response to unfavourable habitat, persistent grazing or recurrent ground disturbance, and differ morphologically in their phyllodes and habit from fertile specimens (possibly neotenous). In an inspection of 48 stands of *Acacia pendula* from across the Hunter undertaken in 2007, all 12 horticultural plantings carried pods and seeds, while the remaining 'natural' specimens did not (unpubl. data). The tracking study shown in Bell (2018) found several environmental stressors acting on *Acacia* individuals, leading to a complete failure of seed production.

Cunningham's Hunter's River collection displays all the traits that are represented in morphotype C as outlined in Bell and Driscoll (2014), and as present at most of the non-horticultural specimens observed in the Hunter. These traits include the presumed infertile nature, the short, straight phyllodes with an indistinct mucro, the high density of phyllodes per branch length, and the generally upright rather than pendulous phyllode habit. It remains uncertain if this collection is *Acacia pendula*, as without fertile material (pods and seed) it is not possible to confidently distinguish it from the closely related *Acacia melvillei* and *Acacia homalophylla*, or any other related taxa. The assumption that such Hunter plants are *Acacia pendula* was largely based on observations of juvenile plants near Warkworth made by *Acacia* expert the late Terry Tame, together with mature plants growing at Jerrys Plains cemetery (T. Tame, pers. comm. 2007). Historical aerial imagery shows the Jerrys Plains plants to have been absent in 1958 (Umwelt 2006), and their presence at this location prior to that date is consequently unknown.

Daston (2004) discussed at length how the concept of the Type for a particular species must be tied to one individual specimen rather than an 'abstract idea' of a species, as was historically the more widespread practice in plant taxonomy. Whenever there is uncertainty regarding the membership of a particular specimen to a species, consultation with the Type should be undertaken. This is supported in Section 2 of the International Code of Nomenclature where it states that a Type is "*either a single specimen conserved in one herbarium or other collection or institution, or a published or unpublished illustration*" (Turland et al. 2004). In the words of Daston (2004), '*...to unsnarl a classificatory tangle requires firsthand inspection of the holotype...*'.

To our knowledge, for *Acacia pendula* in the Hunter Valley (including Cunningham's Hunter's River collection) this process has not been undertaken until now, and the absence of fruiting material has historically necessitated a 'best guess' identification with some level of uncertainty applied. Consequently, a comparison of Cunningham's 1825 Hunter's River collection with the lectotype from the Lachlan River collected in 1817 shows morphological differences between the two (detailed earlier), and it seems likely that two different taxa may be involved. Apart from those horticultural plantings which flower and fruit freely, no individuals of *Acacia pendula* from the Hunter Valley have ever been positively identified with the benefit of fruiting material, and there has been no conclusive genetic studies undertaken. This is of major concern given the species is listed as an endangered population in the Hunter Valley and it forms a key component of a critically endangered ecological community.

Examples from the literature for other taxa illustrate the importance of comparing uncertain material against their Types to resolve complex taxonomic issues, particularly for those taxa with implications for conservation management. Lorimer (2014), for example, found the threatened Tasmanian endemic grass *Rytidosperma popinense* to be well within the expected infraspecific variability of the widespread *R. fulvum* after comparison with the holotype and other collections, relegating *R. popinense* to synonymy after nearly 25 years of acceptance. In other situations, the identity of specimens within species complexes have been resolved following direct comparison to the original Type material (e.g. Ross 1974, Silverside 1991, Conn & Tame 1996, Choi & Duretto 2008). For *Acacia humifusa* Chiov., *nom. illeg.* (non *A. humifusa* A.Cunn. ex Benth.) in Africa, Ross (1974)

was able to match the features from the sterile Type of this taxon to those of *Acacia edgeworthii* T.Anderson [= *Vachellia edgeworthii* (T.Anderson) Kyal. & Boatwr.], thus reducing it to synonymy under that species. Seigler and Ebinger (2015) provided similar clarifications for some Central and South American *Acacia* (*Senegalia*). Although a possible solution for *Acacia pendula*, such an outcome is unlikely given the need for fertile material to distinguish this species from close relatives (i.e. sterile specimens of *Acacia homalophylla* and *A. melvillei* are also difficult to identify without pods).

Conclusion

Despite the mention of *Acacia pendula* in Cunningham's journal from April 1825, and after close examination of his collected material from that time including comparison with the lectotype and current-day nearby stands, there remains scant evidence that this species naturally occurred in abundance in the Hunter Valley prior to European settlement. Potentially, the species may have been naturally very rare in the Hunter Valley, existing in an atypical form in atypical habitat which might explain a lack of collection or mention in journals between 1825 and 1951, but this seems unlikely. Cunningham's collection is sterile, and his allocation to *Acacia pendula* cannot be confirmed applying modern identification keys. Morphologically, his specimen is a poor match to the lectotype, and under nomenclatural guidelines it cannot be determined as *Acacia pendula* with confidence until further supporting information becomes available.

Consequently, we see there to be three possibilities for the sterile plants currently attributable to *Acacia pendula* in the Hunter Valley. Firstly, as discussed in Bell and Driscoll (2014), propagules may have been inadvertently transported into the Hunter from the Liverpool Plains through stock movements in the early- to mid-1800s, and given the different habitat conditions and the process of time. now display neoteny or have adapted to reproduce only asexually (Eckert 2002, Barrett 2015), expanding outwards through vigorous root suckering when grazing pressure is eased. Such a pattern is evident across many stands in the Hunter and can be seen in Figure 16 of Bell (2018). Cunningham's April 1825 collection does present a quandary in this regard, given its very early collection, but he himself remarked that graziers had been present in the Hunter for over two decades by 1825 ('*since the settlement of its banks by Graziers 25 yrs elapsed*'; 23rd April 1825). Perry (1963) noted that formalised settlement commenced in the Hunter around 1813, and that by 1825 the bulk of alluvial plains along the Hunter River had already been occupied or appropriated for agricultural enterprises, with approximately 13,500 head of sheep and cattle present at this time and 6,000 acres (24 km^2) of land cleared or cultivated. It is possible that Cunningham's collection may have originated from one of the first transported propagules during the early 1800s, expressing itself as the infertile and morphologically atypical form that is now so common in the Hunter. However, it was not until 1826–1827 that stock movements onto the Liverpool Plains began (O'Rourke 2009, Hunter 2010), and by late 1829 several large stockholders regularly drove their cattle there (Perry 1963). This lessens the possibility that the plants observed by Cunningham were transported there by cattle, although movements to and from the Liverpool Plains by settlers on horseback are perhaps more likely to have successfully introduced viable seed given ungulates more effective seed dispersal abilities (e.g. Egea et al. 2022).

Secondly, trading or intentional dispersal of *Acacia pendula* by indigenous people may have facilitated introduction as has been reported for other plants (Silcock 2018). The timber of *Acacia pendula* was used to make boomerangs, spearheads and clubs (Mitchell 1838, Kamminga 1988), and many *Acacia* seed were a key food source (Gott 2008). It is plausible, therefore, that seed of *Acacia pendula* was introduced into the Hunter, but inappropriate environmental conditions impacted on growth and subsequently produced sterile, clonal plants.

A third alternative involves the possibility that a separate undescribed taxon or hybrid is present, which like *Acacia atrox* Kodela and some other arid zone *Acacia* (e.g. Andrew et al. 2003, Forrest et al. 2015, Roberts et al. 2017), reproduce only asexually. Based on current day records, such a taxon may be widespread across the Hunter but occurs in landscapes threatened by agriculture and coal mining. This view is difficult to rationalise when the diaries or collections of early botanical explorers (apart from Cunningham's April 1825 collection discussed herein), who clearly traversed much of the lands now supporting this entity (see Figure 3 in Bell and Driscoll 2014), imply its absence or rarity. As is often the case with modern-day collectors, infertile specimens may well have been bypassed by botanists, in the hope that fertile plants may still lay ahead. Confirmation of a new or hybrid taxon, therefore, may well be a possibility and may potentially resolve persistent uncertainties around the presence of *Acacia pendula* in the Hunter. Like Hunter Valley forms of *Acacia pendula*, occasional flowers in both subspecies of *Acacia atrox* never progress to fruit, and the up to 100,000 stems of subsp. *atrox* and several hundred stems of subsp. *planitiicola* Kodela & L.M.Copel. present may all be clonal from one or few individuals (Kodela 2001, Copeland and Kodela 2012). *Acacia carneorum* Maiden, thought to be closely

related to *Acacia atrox*, is also clonal and genetic studies have confirmed that the several thousand stems evident on the ground may represent just 240 individuals (Roberts et al. 2017). With such precedents elsewhere, final resolution of populations currently identified as *Acacia pendula* in the Hunter Valley is recommended for further research, with genetic assessment across all stands building on the work of Forrest et al. (2016) a priority for this and related species.

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